2018 Current Fiscal Year Report: National Space-Based Positioning, Navigation, and Timing Advisory Board

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1. Department or Agency	2. Fiscal Year
National Aeronautics and Space Administration	2018

3. Committee or Subcommittee	3b. GSA Committee No.
National Space-Based Positioning, Navigation, and Timing Advisory Board	29124

4. Is this New During Fiscal Year?	5. Current Charter	6. Expected Renewal Date	7. Expected Term Date
No	05/05/2017	05/05/2019	

8a. Was Terminated During FiscalYear?	8b. Specific Termination Authority	8c. Actual Term Date
No		

9. Agency Recommendation for Next FiscalYear	10a. Legislation Req to Terminate?	10b. Legislation Pending?
Continue	Not Applicable	Not Applicable

11. Establishment Authority Presidential

12. Specific Establishment Authority	13. Effective Date	14. Commitee Type	14c. Presidential?
U.S. National Space-Based Positioning, Navigation, and Timing [PNT] Policy, 12/8/2004. (NSPD-39)	12/08/2004	Continuing	No

15. Description of Committee Scientific Technical Program Advisory Board

16a. Total Number of Reports No Reports for this FiscalYear

17a. Open 3 **17b. Closed** 0 **17c. Partially Closed** 0 **Other Activities** 0 **17d. Total** 3

Meetings and Dates

Purpose	Start	End
National Space-Based Positioning, Navigation and Timing Advisory Board Meeting	11/15/2017	- 11/16/2017
National Space-Based Positioning, Navigation and Timing Advisory Board Meeting	05/16/2018	- 05/17/2018
National Space-Based Positioning, Navigation and Timing Advisory Board Meeting	08/06/2018	- 08/06/2018

Number of Committee Meetings Listed: 3

	Current FY	Next FY
18a(1). Personnel Pmts to Non-Federal Members	$0.00	$0.00
18a(2). Personnel Pmts to Federal Members	$0.00	$0.00
18a(3). Personnel Pmts to Federal Staff	$18,792.00	$18,792.00
18a(4). Personnel Pmts to Non-Member Consultants	$0.00	$0.00
18b(1). Travel and Per Diem to Non-Federal Members	$15,974.00	$15,974.00

18b(2). Travel and Per Diem to Federal Members	$39,470.00	$39,470.00
18b(3). Travel and Per Diem to Federal Staff	$2,000.00	$2,000.00
18b(4). Travel and Per Diem to Non-member Consultants	$0.00	$0.00
18c. Other(rents,user charges, graphics, printing, mail, etc.)	$109,312.00	$109,312.00
18d. Total	$185,548.00	$185,548.00
19. Federal Staff Support Years (FTE)	0.10	0.10

20a. How does the Committee accomplish its purpose?

The National Space-Based Positioning, Navigation and Timing (PNT) Advisory Board provides advice, as directed by the PNT Executive Committee (EXCOM) through NASA, on U.S. space-based PNT policy, planning, program management and funding profiles in relation to the current state of national and international space-based PNT services. The PNT Board Chair and Vice-Chair regularly report progress directly to the Deputy Secretaries of the nine Federal Agencies, and White House offices, that convene at the PNT EXCOM and Assistant Secretary level PNT Executive Steering Group (ESG) 2-4 times per year.

20b. How does the Committee balance its membership?

The PNT Advisory Board membership is balanced by sector and expertise to ensure comprehensive representation for diverse points of view to address the complex national issues to be examined and functions to be performed. The actual Board member nominations come from the nine Federal agencies that comprise the PNT EXCOM to ensure this balanced representation and diverse skillset. The Board is comprised of both U.S. and international members, in recognition of the fact that the U.S. Global Positioning System (GPS) is a global navigation satellite system with a worldwide user community. Membership is augmented by rotating on six new members with expertise in different unique sectors at periodic intervals, to ensure new expertise is brought on even as institutional memory is maintained with a core group.

20c. How frequent and relevant are the Committee Meetings?

The PNT Advisory Board usually meets twice each fiscal year. It remains relevant by responding to current issues and taskings as assigned by consensus through active PNT EXCOM discussion topics, as well as independent assessments brought forward by active PNT Board members representing the various sectors.

20d. Why can't the advice or information this committee provides be obtained elsewhere?

A national Presidential policy was announced on December 8, 2004 that establishes guidance and implementation actions for space-based positioning, navigation, and timing

programs, augmentations, and activities for U.S. national and homeland security, civil, scientific, and commercial purposes. This policy supersedes Presidential Decision Directive/National Science and Technology Council-6, U.S. Global Positioning System Policy, dated March 28, 1996, and remains in effect. The PNT Policy directs the Deputy Secretaries of the PNT EXCOM to establish a space-based Positioning, Navigation, and Timing Advisory Board. The PNT Advisory Board is comprised of experts from outside the United States Government. NASA sponsors and manages the day-to-day operations of the PNT Advisory Board on behalf of the PNT EXCOM, and the committee is NASA's governmental contribution of expertise to ensure appropriate implementation of Presidential policy goals and objectives.

20e. Why is it necessary to close and/or partially closed committee meetings?
N/A. All PNT Advisory Board meetings were open and accessible to the public. There were no closed meetings during FY 2018.

21. Remarks
NASA is managing the operations of this FACA advisory committee part of its governmental contribution to the implementation of National Security Presidential Directive (NSPD-39), in effect since 2004 through three Presidential Administrations. The PNT Advisory Board reports to the Deputy Secretary level PNT Executive Committee (EXCOM), comprised of nine (9) Federal agencies: Department of Defense, Department of Transportation, Department of Commerce, Department of State, Department of Homeland Security, Department of Interior, Department of Agriculture, Joint Chiefs of Staff, and NASA. The PNT EXCOM is co-chaired by the Deputy Secretary of Defense and Deputy Secretary of Transportation, with the NASA Deputy Administrator or their designee as the ranking member. Recommendations and advice is conveyed by the PNT Advisory Board Chair to meetings of the PNT EXCOM, and are formally documented in the PNT Advisory Board meeting minutes.

Designated Federal Officer
James J. Miller DFO/Executive Director

Committee Members	Start	End	Occupation	Member Designation
Allen, Thad	05/08/2015	05/05/2019	Booz-Allen Hamilton	Special Government Employee (SGE) Member
Axelrad, Penina	05/08/2015	05/05/2019	University of Colorado	Special Government Employee (SGE) Member
Betz, John	05/08/2015	05/05/2019	MITRE	Special Government Employee (SGE) Member
Beutler, Gerhard	05/08/2015	05/05/2019	International Association of Geodesy	Representative Member
Brenner, Dean	05/08/2015	05/05/2019	Qualcomm Inc.	Special Government Employee (SGE) Member

Burgett, Scott	05/08/2015	05/05/2019	Consultant	Special Government Employee (SGE) Member
Burns, Joseph	05/08/2015	05/05/2019	United Airlines	Special Government Employee (SGE) Member
Camacho-Lara, Sergio	05/08/2015	05/05/2019	Regional Centre for Space Science and Technology Education for Latin America and the Caribbean	Representative Member
Ciganer, Ann	05/08/2015	05/05/2019	U.S. GPS Industry Council	Representative Member
Dimmen, Arve	05/08/2015	05/05/2019	Norwegian Coastal Administration	Representative Member
Enge, Per	05/08/2015	05/05/2019	Stanford University	Special Government Employee (SGE) Member
Faga, Martin	05/08/2015	05/05/2019	Former President and CEO of MITRE	Special Government Employee (SGE) Member
Geringer, James	05/08/2015	05/05/2019	Environmental Systems Research Institute	Special Government Employee (SGE) Member
Goward, Dana	05/08/2015	05/05/2019	Resilient Navigation and Timing Foundation	Representative Member
Hatch, Ronald	05/08/2015	05/05/2019	NavCom Technology, Inc.	Special Government Employee (SGE) Member
Higgins, Matt	05/08/2015	05/05/2019	International GNSS Society (Australia)	Representative Member
James, Larry	05/08/2015	05/05/2019	Jet Propulsion Laboratory	Special Government Employee (SGE) Member
Marquez, Peter	05/08/2015	05/05/2019	Orbital Sciences Corporation	Special Government Employee (SGE) Member
McGurn, Terence	05/08/2015	05/05/2019	Retired CIA (currently, private consultant)	Special Government Employee (SGE) Member
Murphy, Timothy	05/08/2015	05/05/2019	The Boeing Company	Special Government Employee (SGE) Member
Neilan, Ruth	05/08/2015	05/05/2019	Jet Propulsion Laboratory	Special Government Employee (SGE) Member
Parkinson, Bradford	05/08/2015	05/05/2019	Stanford University	Special Government Employee (SGE) Member
Rashad, Refaat	05/08/2015	05/05/2019	Arab Institute of Navigation (Eqypt)	Representative Member
Shields, T.	05/08/2015	05/05/2019	Ygomi, Founder	Special Government Employee (SGE) Member
Stembit, John	05/08/2015	05/05/2019	Consultant	Special Government Employee (SGE) Member

Number of Committee Members Listed: 25

Narrative Description

The PNT Advisory Board is NASA's contribution to implementation of the U.S. National PNT Policy, where The Administrator of the National Aeronautics and Space Administration, in cooperation with the Secretary of Commerce, shall develop and provide to the Secretary of Transportation requirements for the use of the Global Positioning System and its augmentations to support civil space systems. The PNT Board has therefore provided NASA, and the eight other Federal agencies of the PNT EXCOM, with expert technical and policy advice to ensure that national and international GPS/PNT needs can continue to be met as the constellation is modernized and the spectrum environment becomes more challenged from radio frequency interference. Specific analysis is conducted to develop actionable recommendations for the PNT EXCOM to consider implementing in support of meeting NSPD-39 goals and objectives.

What are the most significant program outcomes associated with this committee?

	Checked if Applies
Improvements to health or safety	✓
Trust in government	✓
Major policy changes	✓
Advance in scientific research	✓
Effective grant making	
Improved service delivery	✓
Increased customer satisfaction	✓
Implementation of laws or regulatory requirements	✓
Other	✓

Outcome Comments

While the PNT Board cannot assume full direct credit for causing the PNT EXCOM and associated Federal agencies to act on specific recommendations, there is most definitely a correlation between what the PNT Board advises and what the PNT EXCOM has actually been implementing and planning to ensure GPS services are protected and made more accessible on a less expensive basis to the world user communities. In this regard the work of the PNT Board has positively assisted NASA and the Federal government in accomplishing its objectives, with some specific examples cited in the comment sections below.

What are the cost savings associated with this committee?

	Checked if Applies
None	
Unable to Determine	
Under $100,000	
$100,000 - $500,000	
$500,001 - $1,000,000	
$1,000,001 - $5,000,000	
$5,000,001 - $10,000,000	
Over $10,000,000	
Cost Savings Other	

Cost Savings Comments

A key recommendation that has direct value measurable in the 10s of millions of dollars is adoption of an enhanced GPS Space Service Volume (SSV) for emerging civil space users (NASA, NOAA, commercial space, etc.,). The SSV is a volume of space where

GPS broadcasts that ranges from 3,000 Km to 36,000 Km, an altitude where Geosynchronous communications satellites operate. The PNT Board recommended that the Air Force adopt the use of existing GPS signal side lobes to enable more civil space users to access PNT information in the challenging space domain. This capability would enable new missions such as the GOES series of weather satellites, formation flyers, and even satellite servicing missions. However the Air Force quoted NASA a price of enabling this capability as a new requirement -- for a price range from $226M to $1.2B. After much technical debate by PNT Board members, this excessive cost was dramatically reduced by the Air Force in an effort to capture capabilities already available and measured by NASA, rather than forcing a potentially unneeded hardware modification to new GPS satellite vehicles being built. The end result is that the Air Force is now working with NASA to minimize costs and hardware changes for this enhanced capability, and has allowed for a NASA representative to participate on the GPS IIIF procurement team. In FY18, the United Nations Office for Outer Space Affairs published a Space Service Volume (SSV) document that enables interoperability between GPS and other PNT constellations for space applications.

What is the approximate Number of recommendations produced by this committee for the life of the committee?
9

Number of Recommendations Comments
Recommendation 1: Spectrum RNSS Protection: After a thorough analysis of the latest data available to the board, the non-recused members voted and concurred with a Spectrum RNSS Recommendation to the PNT EXCOM, which was signed and submitted on Aug. 10. The recommendation is to reject the latest Ligado terrestrial broadband communications transmitter power proposal. The board's view is that it does not meet the PNT EXCOM January 2012 goal to protect "existing and evolving uses of space-based PNT services". The board also recommended that any future modification of this proposal, or new proposals, should apply the results and methodologies of the Department of Transportation (DOT) Adjacent Band Compatibility (ABC) study. See: https://www.gps.gov/governance/advisory/recommendations/2018-08-letter-to-excom.pdf The PNT EXCOM has issued a memo supporting these recommendations. Not doing so may have resulted in implementation of the Ligado proposal and create totally unacceptable interference for a great number of GPS users in the United States, in particular high performance users such as surveyors, intelligent agriculture, etc, which are the most valuable to the U.S. economy where a recent PNT EXCOM study ascribed over $31 Billion in annual benefits from high performance applications. Thus, we can consider this recommendation 100% adopted. Recommendation 2: PNT Topics Paper / Protecting,

Toughening, and Augmenting GPS: On Oct. 2 the PNTAB completed and submitted to the PNT EXCOM a “Topics Paper” document for administration briefings describing GPS uses, benefits, and threats to GPS use, as well as recommended high level actions to protect, toughen, and augment GPS across various sectors, including: agriculture, aviation & aerospace, critical infrastructure & timing, military, GPS policy & governance, science, spectrum, and transportation (nonaviation). See https://www.gps.gov/governance/advisory/recommendations/2018-09-topic-papers.pdf for the full list of recommendations across all sectors. The Topics Paper examine PNT applications and uses in several critical areas, and include recommendations for further engagement by PNT EXCOM member agencies, departments, and stakeholders. The ultimate goal is to protect and enhance the worldwide utility and reach of GPS even as new GNSS constellations are being deployed by other nations. The reasons for this are simple, yet authoritative. GPS services, such as precision timing, have become thoroughly integrated into every facet of the U.S. economy. Estimates of the economic value of GPS to the U.S. are as high as US$ 2.9 Trillion/year, but because of the ubiquity and impact of GPS on the economy and national security the true value is beyond calculation. The board’s Recommendations are intended to help preserve such critical national capabilities. Of these recommendations, those summarized below are of the utmost importance to maintain U.S. leadership in core sectors. The continued and successful execution of the GPS Enterprise will require PNT EXCOM vigilance and committed governance: Recommendation 2.1: Continue the support of on-going GPS modernization, including space, control and user segments Status: The U.S. must maintain its leading edge among world satellite-based navigation and timing systems. Over the years the Air Force has been very responsive to the PNTAB concerns and, at this time, GPS is still the Gold-Standard for all international Global Navigation Satellite Systems. Thus, we can consider this recommendation 100% adopted. Recommendation 2.2: Ensure that complementary and back-up capabilities for GPS-derived PNT are available and used to protect the nation’s critical infrastructure and public-safety applications Status: The board has recommended to implement Enhanced Loran (eLoran) as a back-up for GPS timing in the continental U.S., subject to verification of cost and performance. Further, it recommends that U.S. agencies should continue the development of additional capabilities that reinforce PNT resiliency. DHS has recognized the importance of PNT to U.S. critical infrastructure and is assessing backup needs for U.S. critical infrastructure. Thus, we can consider this recommendation ~ 50% adopted pending a final decision to implement and fund a backup. Recommendation 2.3: Protect GPS signals from interference - Status: The potential for more powerful radio signals in adjacent bands and on-going deliberate disruption by malicious actors remain real and present dangers that will continue to grow. The PNT EXCOM has implemented the PNTAB recommendation to protect GPS users from adjacent band terrestrial transmissions, and work continues

towards developing capabilities to detect harmful interference to GPS users and develop mitigation strategies. Thus, we can consider this recommendation ~ 75% adopted pending implementation of interference detection and mitigation strategies across all agencies. Recommendation 2.4: Encourage the use of toughened GPS receivers which can resist interference such as jamming and spoofing, especially in critical applications Status: The technology is available commercially, but it is not being used to its fullest extent. At this time we can consider this recommendation ~50% adopted. Recommendation 2.5: Permit users in the U.S. to access other nations' properly vetted GNSS signals - Status: This will increase resilience, receiver performance, and legitimize many receivers already in service. The FCC, after two years, has completed its review of a waiver request by Galileo (Europe's GNSS) for use of its L1 and E5 signals in the U.S. Use of the GLONASS and BeiDou GNSS is, technically, still not authorized in the U.S. even though many users already rely on their signals. Thus, at this time we can consider this recommendation ~33% adopted. Recommendation 2.6: Demonstrate the utility of backup/augmentation of allied GNSS signals in military receivers Status: This could allow improved resilience, assurance, and GPS back-up capabilities to military operations in increasingly contested environments. However, the DoD is still resistant to rely on allied GNSS (namely Europe & Japan), but the Air Force has shown openness to study this further. Thus, at this time we can consider this recommendation ~20% adopted. Recommendation 3: Developing an Interoperable Multi-GNSS Space Service Volume Global navigation satellite systems (GNSS), which were originally designed to provide positioning, velocity, and timing services for terrestrial users, are now increasingly utilized for autonomous navigation in space as well. Historically, most space users have been located at low altitudes, where GNSS signal reception is similar to that on the ground. More recently, however, users are relying on these signals at high altitudes, near to or above the GNSS constellations themselves. High-altitude applications of GNSS are more challenging than terrestrial or low Earth orbit (LEO) applications due to a number of factors. The Space Service Volume is currently defined as the region of space above 3000 km altitude up to Geosynchronous Orbit (GEO) altitude (36,000 km). An interoperable Multi-GNSS SSV concept expands on the GPS SSV concept to improve resilience from outages from any one GNSS and, also, improved on-board autonomous real-time navigation for spacecraft. As such, NASA co-chaired a multi-year effort with the European Space Agency to International Committee for GNSS (ICG) Working Group B (Enhancement of Performance of GNSS Services), and other technical for a, to develop an interoperable GNSS SSV that that aggregates the capabilities provided by GPS (U.S.), GLONASS (Russia), Galileo (Europe), BeiDou (China), and regional navigation systems such as Japan's QZSS and India's NavIC. - Status: A specific outcome of this recommendation is the United Nations information booklet "The Interoperable Global Navigation Satellite Systems Space Service Volume", officially presented at the 13th

Meeting of the International Committee on Global Navigation Satellite Systems held Nov. 4-7, 2018, in Xian, China. The information booklet is now available in printed form at the UN HQ in New York and online: http:www.unoosa.org/oosa/en/ourwork/icg/documents/publications.html Thus, at this time we can consider this recommendation ~100% adopted. When accessing the signals from all GNSSs, and regional navigation systems, there would be much improved capabilities to perform real-time on-board navigation at higher altitudes and, also, to obtain improved accuracy from using GNSS signals that are more optimally distributed in space (best geometry). Increased satellite autonomy and PNT performance will results in savings to space agencies and U.S. commercial operators in $ hundreds of millions.

What is the approximate Percentage of these recommendations that have been or will be Fully implemented by the agency?
56%

% of Recommendations Fully Implemented Comments
The PNT Board has developed an integrated set of actions to protect, toughen, and augment (PTA) GPS, which have become guidelines for PNT service providers and GPS/GNSS users alike. These recommendations still being refined and adopted, are highlighted below:-- The continued support of on-going modernization of the GPS space, ground, and user segments to ensure the U.S. maintains leading edge capabilities around the world.-- Cost-effective back-ups and complementary technologies for GPS-derived timing, to help ensure the health of the nation’s critical infrastructures. The board endorses the government’s studies and decisions to implement a terrestrial eLoran (Enhanced Loran) system as part of this effort, especially with respect to timing for critical networks. -- Protect the ubiquitous use and great economic benefits of GPS from the encroachment of more powerful radio communications signals in adjacent bands. Navigation signals are fundamentally different from communications signals in terms of how they are processed, which requires careful regulatory consideration.-- Existing international and national regulations governing radiofrequency use have enabled GPS to become globally pre-eminent. Committed spectrum leadership and effective national regulations can protect the GPS utility while enabling new communications services where feasible. Continuing with prudent spectrum management will enable continued realization of the benefits of GPS PNT innovation for the nation and society at large.-- Use of foreign GNSS is recommended to complement GPS and improve resiliency. However, before including its use in critical infrastructure services, we will establish that these services meet standards of accuracy and integrity that will enhance user performance.

What is the approximate Percentage of these recommendations that have been or

will be Partially implemented by the agency?
33%

% of Recommendations Partially Implemented Comments
Several recommendations are still being worked as the PNT EXCOM and the GPS program are multi-year efforts with multiple initiatives. However another productive deliverable from the PNT Board based on testing, analyses, and results discussion is the development of agency positions on radio frequency interference (RFI) to GPS Federal infrastructure, from such sources as the newly proposed terrestrial networks to transportable GPS jammers. Several agencies are now taking a more proactive role on PNT Board recommendations based on the need to protect such critical infrastructure for key agency missions. in FY18, there was an enhanced focus on detecting intentional jamming and establishing tougher penalties for those that used such devices to harm the public's access to GPS PNT services.

Does the agency provide the committee with feedback regarding actions taken to implement recommendations or advice offered?
Yes ☑ No ☐ Not Applicable ☐

Agency Feedback Comments
The PNT Board Chair and two Vice Chairs report directly to the Deputy Secretary level PNT EXCOM. As such, they recieve periodic feedback in real time from NASA and their other associated sponsors. The NASA Deputy Administrator participates directly as a member of the PNT EXCOM in all discussions revolving around the taskings and deiverables of the PNT Board.

What other actions has the agency taken as a result of the committee's advice or recommendation?

	Checked if Applies
Reorganized Priorities	☑
Reallocated resources	☑
Issued new regulation	☑
Proposed legislation	☑
Approved grants or other payments	☐
Other	☑

Action Comments
The priorities of both the PNT EXCOM, and the PNT Board, were modified to address immediate interference threats to GPS such as the proposed terrestrial networks

operating in Mobile Satellite Services (MSS) radio bands. Many resources were thus rechanneled to assist in developing mitigation strategies and techniques, which were developed into the above spectrum testing criteria. Although the threat of some of these proposals is still immediate, the expertise of the PNT Board has enabled the GPS community to proactively prepare for more expected FCC spectrum sharing proposals. Also, a more aggressive Protect, Toughen, Augment (PTA) approach to preventing GPS RFI events has been adopted by all PNT EXCOM agencies. The work has led to proposals to improve regulations and statutes such that spectrum interferers are penalized more severly while safe & effective use of spectrum is rewarded.

Is the Committee engaged in the review of applications for grants?
No

Grant Review Comments
Not Applicable

How is access provided to the information for the Committee's documentation?

	Checked if Applies
Contact DFO	✓
Online Agency Web Site	✓
Online Committee Web Site	✓
Online GSA FACA Web Site	
Publications	✓
Other	✓

Access Comments
All PNT EXCOM agencies assist with getting information out to the general public on the PNT Board's activities to maximize the usefulness of the information that is generated. More information can be found at:http://www.gps.gov/governance/advisory/